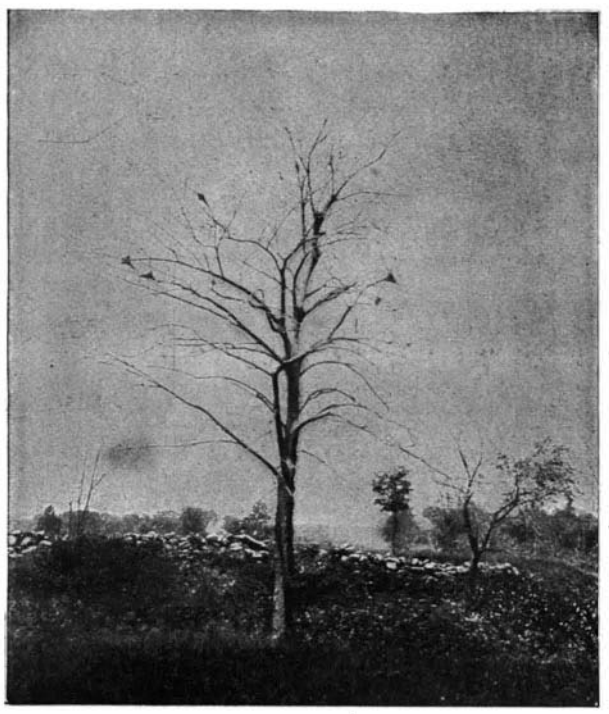
in a separate cage a swallow which had its nest under the gable roof of the railroad station at Antwerp. On August 17, at 7:30 in the morning, all the birds were liberated at Compiegne; the swallow took a northern direction as quick as lightning, while the pigeons made several spirals in the air before they started in the same direction. The swallow arrived at its nest in Antwerp at 8:23, a number of witnesses being present at its arrival. The first pigeons only arrived at their destination at 11:30 of the same morning. The swallow had, therefore, covered the entire distance of 146½ miles in one hour and eight minutes, which is equal to a speed of 128½ miles per hour, or about 189 feet per second, which is equal to more than double the average speed of the fastest train in the world. The pigeons only reached a speed of 35 miles an hour, or 48 feet per second. It may be gathered from these figures how rapidly the migrations of swallows take place, as with the speed mentioned above it would take them only half a day to fly from Belgium or central Germany to northern Africa.

Other careful measurements about the speed of carrier pigeons show results similar to those arrived at by Verschuren. Of 300 full grown pigeons, about 12 per cent. attained a speed of 60 feet per second at distances of from 95 to 125 miles. At distances of from 50 to 100 miles the average was but a trifle less. The maximum attained in any case was from 68 to 70 feet per second. For very short distances pigeons have been observed to fly 104 feet per second, but in long distances this speed can never be attained, for pigeons will not fly in a straight line, but, following the currents of the air, they describe zigzag lines. In the trials of pigeon flying by the Paris daily, Petit Journal, the highest speed attained was also 68 feet per second over a distance of 95 miles from Abbeville to Paris. This establishes the mean speed of pigeons at an average of 48 feet per second, and the highest speed at 70, figures which are rather conservative, considering the speed claimed for some exceptionally high-priced birds.

BEECH TREE DEFOLIATED BY TENT CATERPILLARS.



A WILD CHERRY TREE IN "THE LEAFY MONTH OF JUNE."

THE TENT CATERPILLAR.*

By Clarence M. Weed.

Among the many insect pests of the Granite State none is more in evidence during spring and early summer than the tent caterpillar, † which for more than a century has ravaged the orchards of New England. In 1790 Samuel Dean wrote from Portland, Mass.: "The principal inconvenience the farmer meets with from caterpillars is the damage they do to his orchard. A hairy kind of caterpillars build their nests on apple trees in May, and are gone entirely in June. But they feed so industriously on the leaves as to destroy a great part of them if they be not timely prevented. As they are far less mischievous than the canker worm, so they are more easily subdued." ‡

Apparently, many people do not realize the seriousness of the injury when a fruit tree is stripped of its leaves. In its effort to repair the damage the tree will put out new foliage, thereby using up the stored materials that otherwise would be utilized for growth or fruit. Even in case no blossoms appear the season the damage is done, so that no loss of fruit that year may be felt, the effects will be evident in next year's crop.

The injury done by the tent caterpillar is at once distinguished from that of the canker worm by the fact that the former eats the body of the leaf, veins and all, leaving only the midrib or larger veins (Fig. 3), while the canker worm feeds upon the surface of the leaf, leaving the brown network of veins. A severe attack of the tent caterpillar renders the tree almost as bare in June as it is in midwinter—a condition shown in the illustration of the wild cherry tree—while a similar attack by the canker worm gives the tree a brown appearance, as if it had been scorched by fire.

* From Bulletin 38, New Hampshire College Agricultural Experiment Station, Durham.

† Clisiocampa americana.

‡ New England Farmer or Georgical Dictionary, 1790, p. 41.

THE HISTORY OF A CATERPILLAR'S LIFE.

Few insects pass so long a portion of the year within the eggs as do the tent caterpillars. In July the eggs are laid in masses of 200 or more in a cylindrical cluster upon the twigs of apple and wild cherry. After they are deposited the parent moth covers them with a viscid liquid, which dries into a sort of varnish that completely coats them, as represented in Fig. 4. The insect remains in this egg state from July until the following spring, when the little caterpillars emerge from the eggs and begin feeding upon the tender foliage of the buds about them. In a few days they begin to make a silken tent, utilizing generally, for this purpose, a fork of the branch. As time goes on the nest is enlarged. The cat rpillars retire to the tent at night, and during cold and wet weather, and when not feeding. They have regular times for their meals, leaving and returning to the nest in processions. They become full grown in about six weeks, being extremely voracious during tha latter part of their development. They are then nearly two inches long, with a hairy body, ornamented with a distinct white stripe along the middle of the back, on each side of which are numerous short, yellow longitudinal lines, rather irregularly arranged. The sides are partially covered with paler lines, spotted and streaked with blue, while the lower surface of the body is black. The full grown caterpillar is represented in Fig. 5.

Fig. 4.—EGG MASS (Original).

When the caterpillars become full grown most of them leave the tree where they have developed, and crawl about in search of shelter. Early in June thousands of these caterpillars may be seen rapidly crawling along the ground, especially by the roadside. When they find a satisfactory situation, beneath a board, in the cracks of a fence or between pieces of rough bark, they spin an oval, silken cocoon (Fig. 6), yellow when completed, within which they change to the quiet pupa or chrysalis state.

Two or three weeks later another change takes place, and from each cocoon there comes forth a reddish brown moth (Fig. 7). The male moths are considerably smaller than the females. These moths are nocturnal, flying only at night, and are to be found throughout the greater part of July. The females deposit the eggs upon the twigs of trees and soon die. As already stated, these eggs remain unhatched until the following spring.

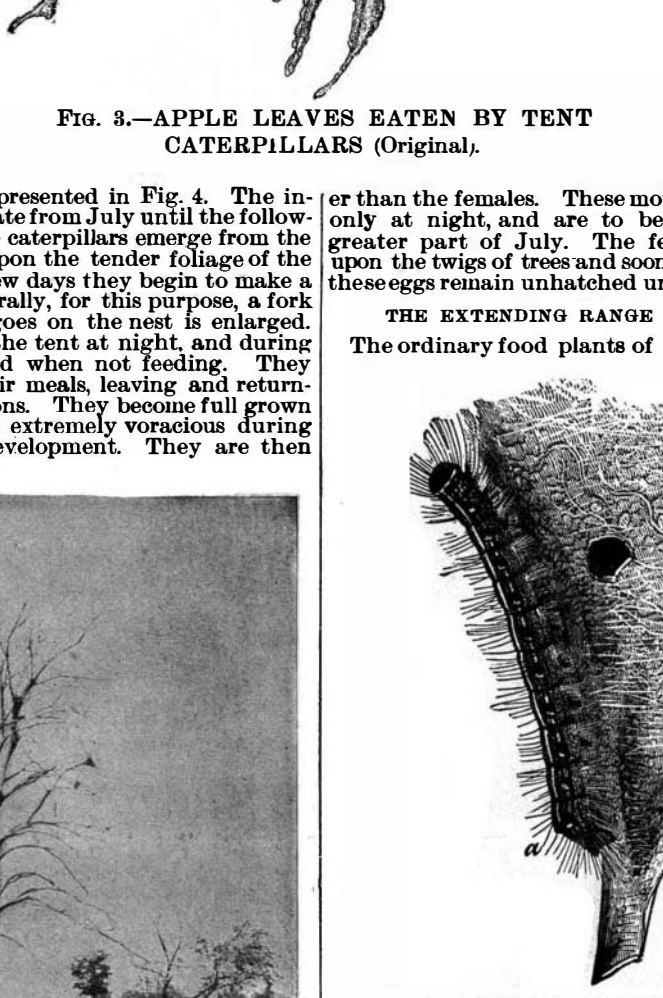


Fig. 3.—APPLE LEAVES EATEN BY TENT CATERPILLARS (Original).

THE EXTENDING RANGE OF FOOD PLANTS.

The ordinary food plants of the tent caterpillar are the apple and the various kinds of wild cherry. The moths apparently choose these in preference to all other trees for the reception of the egg masses. But during the outbreaks of the insect in New England the last few years, as, in fact, in previous outbreaks in other regions, many of the caterpillars have been forced by hunger to attack the foliage of other trees and shrubs. In many localities the leaves of the apple and cherry trees upon which the insects fed when first hatched have been wholly devoured before the caterpillars were half grown. Of course this must be the result when more egg masses are laid upon a tree or shrub than can be matured upon its leaves. Thus threatened by starvation the caterpillars have been forced to leave their nests, descend to the ground, and crawl about in search of food. Many of them ascend the nearest trees and shrubs, and nibble at their leaves. If these leaves are not too distasteful, the caterpillars are likely to remain and complete their growth upon the new food plant thus found.

Fig. 5.—TENT CATERPILLAR (After Riley).

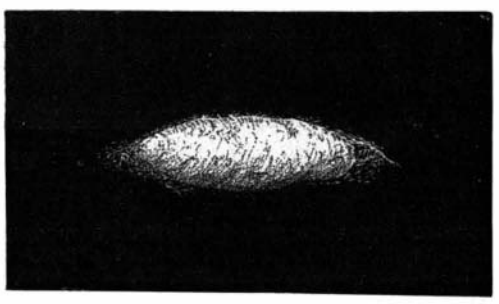


Fig. 6.—COCOON OF TENT CATERPILLAR (Original).

Fig. 7.—FEMALE MOTH (After Riley).

But it is very probable that many of these caterpillars which are able to complete their larval growth upon new food plants will survive all vicissitudes and mature into moths that apparently are likely to deposit eggs upon the variety of tree that has furnished them

food. In this way the insect will be likely soon greatly to extend the limits of its food supply and become much more difficult to subdue than it now is. The case is suggestive of the famous gypsy moth that has lately been causing such alarm in Massachusetts.

That this is not an imaginary danger can be seen from Fig. 8, showing the work of the tent caterpillar

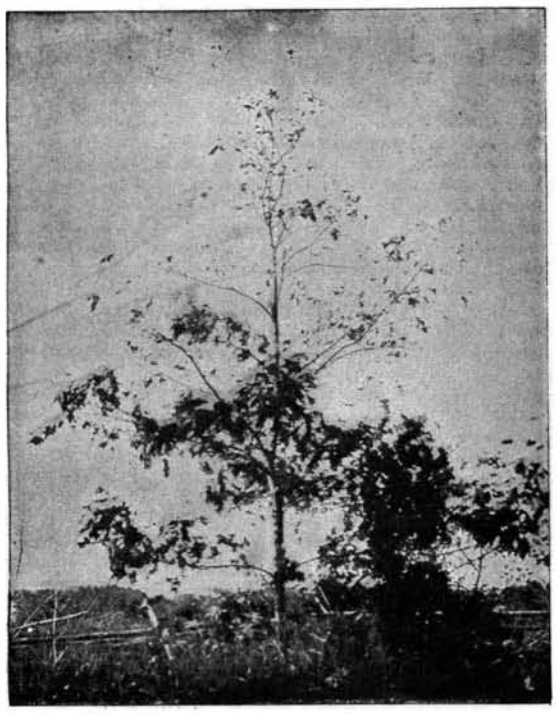


FIG. 8.—OAK TREE PARTIALLY DEFOLIATED BY TENT CATERPILLARS (Original).

upon trees and shrubs not on its usual bill of fare. It is well known that insects have family preferences in the matter of food; that if a given insect feeds upon a given plant, we need not be surprised to find it also upon another plant closely related, belonging to the same family.

In view of this we should expect the tent caterpillar when it was forced to increase its range of food to attack the peach, cultivated cherry, rose, and other plants of this family. This has been done, and each of these is now on the tent caterpillar's food list, but we have also found it feeding freely and apparently thriving upon such widely separated plants—so far as botanical kinship is concerned—as the oaks (Fig. 8), the hickories, the birches, the barberry, and the willows and poplars. I found a large tent even upon the low evergreen known as the juniper, but the caterpillars from it evidently fed upon a neighboring barberry.

DISEASES AND OTHER NATURAL ENEMIES.

During the latter part of the caterpillar season one can frequently find dead and dying caterpillars upon the outside of the tent, stretched at full length. Some of these will be simply sluggish, others evidently nearly dead, others dead and rupturing at a touch, letting escape the liquid decomposed body contents. Some will be hanging by one end of the body to the tent or twig, as shown in Fig. 9. These caterpillars appear to be affected by one of the bacterial diseases that are

FIG. 9.—DISEASED TENT CATERPILLARS (Original).

known to develop in many insect larvæ when they become very abundant. The army worm and common cabbage worm are frequently destroyed in great numbers by such diseases.

After the tent caterpillars are half grown there may be found in many of the nests small dead specimens with the body swollen and the skin dry and hard. (Fig. 10). If these are placed in bottles by themselves, a

FIG. 10.—PARASITIZED CATERPILLAR (Original).

fortnight or so later small four-winged flies will emerge from them. These are parasitic ichneumon flies. They have developed from eggs placed in the young caterpillars by similar parent flies, the eggs hatched into grubs or larvæ that developed on the inside of the caterpillars, killing them and absorbing all the bodies except the skin.

Comparatively few birds feed upon hairy larvæ like the tent caterpillar, but some, like the cuckoos and blue jays, devour them eagerly. Many observers have noticed that both the black-billed and the yellow-billed cuckoos feed upon the tent caterpillars. For example, Mr. C. E. Bailey states: * "On May 10 a black-billed cuckoo came into a tree near me at 3 P.M., and sat there until 4:40 P. M., then he went straight to a tent caterpillar's nest. He looked it over for a short time, and then commenced eating the caterpillars. He picked twenty-seven caterpillars out of the nest before he stopped. The bird ate them all and did not drop one."

Mr. E. H. Forbush gives* the following list of birds found feeding on tent caterpillars in a Massachusetts orchard in 1895: Crow, chickadee, Baltimore oriole, red-eyed vireo, yellow-billed cuckoo, black-billed cuckoo, chipping sparrow, yellow warbler.

My observations upon the natural checks upon the tent caterpillar lead me to believe that it is not good

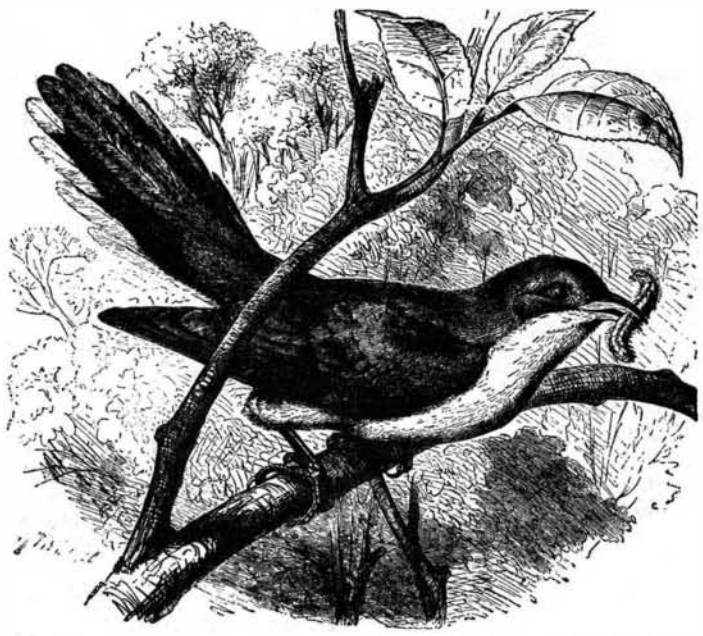


FIG. 11.—YELLOW-BILLED CUCKOO (After Brehm).

policy to depend upon them for subduing the pests. It will be much better for the intelligent people of each community to attempt to arouse public opinion, so that each man will destroy the caterpillars upon his own premises and along the adjoining roadsides.

METHODS OF DESTROYING TENT CATERPILLARS.

1. Destroying the Eggs.—During winter and early spring the egg masses may readily be seen upon the smaller branches, and are easily removed and burned. In this work boys may be employed to advantage; their sharp eyes and nimble limbs are likely to accomplish as much as their elders. A few winters since a society in a Massachusetts town offered prizes to the youngsters of the community for the collection of the tent caterpillar egg masses, and thousands were thus destroyed. The same result may to a large extent be accomplished by cutting off and burning the thickets of wild cherry that line the roadsides and stand in clusters in pastures and fields. This should be done after the eggs are laid, and before they are hatched—any time between September 1 and April 1 would do. Such a burning of the wild cherry would also destroy millions of spores of black knot—the fungous disease

FIG. 12.—ASBESTOS TORCH.

that is always threatening cultivated plums and cherries because of its almost universal presence on the wild cherries. The pest-breeding, neglected apple trees bearing natural fruit, so often seen along the roadside, should also be converted into firewood, and the branches burned during fall or winter.

2. Killing the Young Caterpillars.—When the caterpillars are young and the nests are small, it is easy to destroy the colony by swabbing it out of the crotch with a mass of rags, a gloved hand, a forked stick, a scrubbing brush, or almost anything that can be used to crush the tiny worms huddled beneath the tent. In rainy weather one can generally find them in the tent almost any time, while in fair weather they may be attacked either early or late in the day. "A slender pole long enough to reach the highest nest in the tree," writes Mr. A. S. Fuller, "with two or three shingle nails driven through the end, leaving the heads sticking out a half inch, makes a very handy and efficient implement for dislodging the nest and caterpillars. By thrusting the end into the tent and then twisting it around two or three times the tent will be rolled about the end and can be drawn forth with contents," and destroyed.

* Massachusetts Crop Report, July, 1895, p. 29.

There appears to be a considerable variation in the time of hatching of the different egg masses, so that it is often necessary to go over the trees more than once to get all the nests. As a rule, one should not be satisfied with a single attack upon the pests, but should renew the battle if necessary.

3. Burning with Torches.—A rather common method of destroying tent caterpillars is to burn them out by means of some substance saturated with kerosene. An asbestos torch advertised by the seedsmen and implement dealers for this purpose is represented in Fig. 12. The asbestos is saturated with kerosene, lighted and held under the tents for the cremation of the caterpillars. Rags tied to the end of a pole and saturated with kerosene are also used, as well as various other devices. But burning is a remedy which is likely to cause more harm than good. I have seen a fine young apple tree killed by the use of a torch on its tent caterpillars, and have known many larger trees to be seriously injured in the same way.

4. Spraying with the Arsenites.—On many accounts there is no more satisfactory method of subduing the tent caterpillar in the orchard than by spraying with Paris green or London purple mixed with water. Not only is this pretty certain to kill off all the young

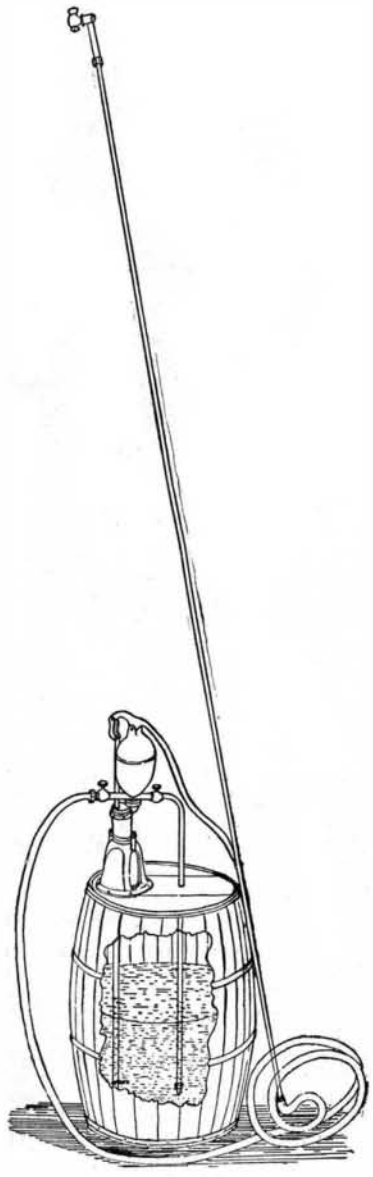


FIG. 13.

caterpillars on the trees, but it also destroys canker worms and also other leaf eating caterpillars as well as the larvæ of the codling moth or apple worm, discussed in Bulletin 35 of this station.

Fortunately spraying has been adopted by a great many commercial fruit growers as an essential part of the season's operations, and the practice is growing in favor yearly. Four or five ounces of Paris green, with a pint or two of fresh lime water, are added to a barrel holding forty or fifty gallons of water, thoroughly

mixed and sprayed upon the trees soon after the worms hatch, by means of a force pump and spray nozzle. A simple and effective spraying outfit, which has been used to good advantage in the experiments at this station, is represented in Fig. 13. It consists of a kerosene barrel holding fifty gallons, a force pump having a double discharge, with a short line of hose running into the barrel to keep the liquid stirred, and a long line of hose fitted at the end to a slender brass rod

FIG. 14.—TENT CATERPILLAR ON OAK (Original).

tipped with a spray nozzle. The outfit can be obtained through any hardware dealer, or direct from any of the numerous manufacturers of spraying machinery.

TRICHOPILIA COCCINEA.

BY the kindness of Sir Trevor Lawrence, Bart., says the Gardeners' Chronicle, we are enabled to give an illustration of a very fine specimen of Trichopilia coccinea which he saw in the gardens of Mr. Otto Froebel at Zurich, and a photograph of which he obtained, and forwarded to us, remarking: "It is one of the finest examples of successful cultivation I have ever seen."

Probably, since its first introduction from Central America, where Warscewicz discovered it in 1849, no plant of equal beauty to this has flowered in gardens: and such a display of carmine crimson flowers among

TRICHOPILIA COCCINEA—GROWN BY HERR OTTO FROEBEL, ZURICH.

the bright green pseudo-bulbs and foliage must form a charming picture, some idea of which a glance at our illustration will give.

DEPTHS OF THE HEAVENS.

IN the recent progress which has been made in the study of the heavens, the photographic plate has played a most important part. Indeed, the facilities which the resources of photography have placed at the disposal of the astronomer are every day increasing. The older methods of observation are in many cases gradually being displaced by the more accurate and far more comprehensive methods which the camera offers. It has been asserted, and I do not think that the truth of the assertion will be questioned, that the advance in the astronomer's art, which is due to the introduction of the photographic plate into the observatory, is not less far reaching in its effects than the advance which was inaugurated when Galileo first turned his newly made telescope to the sky, and thus wonderfully augmented the space penetrating power of human vision.

Almost the first feature which will strike the observer who is examining a good photograph of the sidereal depths is that, though there may be hardly any part of the area presented which is quite free from stars, yet that they are distributed with very great irregularity. In some regions the stars are aggregated in countless myriads; indeed, in many parts of the heavens they lie so closely packed that the individual points can hardly be distinguished separately. Ordinary observation, even with the unaided eye, prepares us in a measure for this striking irregularity in stellar distribution.

Who has not often dwelt with admiration on that glorious stellar girdle which we know as the Milky Way? It is a mighty zone of stars surrounding our solar system. Indeed, a just estimate of the relation of the sun to other bodies in the scheme of the universe would regard our great luminary merely as one of similar stars aggregated in countless myriads to form the Milky Way. From the peculiar nature of the stars in the Galaxy, as this system is often called, it is quite obvious that these wonderful starry clusters have some bond of connection between their component parts due probably to a common origin. To realize the splendor of the Milky Way we have to remember that, minute as the stars of which it is composed may seem from where we are situated, yet each one of these stars is in truth shining with the independent brilliancy of a sun. It might have been thought that it would have been quite impossible for an object so vast and so bright as our sun to display no greater splendor than that feeble twinkle which is all that reaches us from one of the stars in the Milky Way. Here, however, the question of distance is of paramount importance.

If the sun which shines in our skies were to be withdrawn from our neighborhood into the depth of space, if it were to be carried to a distance as remote as is that of many of the stars which we see around us, our great luminary would have lost all of its pre-eminent splendor, and would have dwindled to the relative insignificance of a small star not nearly so bright as many of those stars which shine over our heads every night. I do not, indeed, say that each and every one of the stars in the Milky Way is as large as our sun; no one who understood the evidence would have the hardihood to affirm so gigantic a proposition. At the same time I should add that I do not know any grounds on which such a statement could be certainly contradicted if any one did affirm it. The probability seems to be that, though many of the stars in the Milky Way may resemble our sun in luster or dimensions, yet there are in that marvelous group suns lesser and greater in nearly as many grades of magnitudes as there are objects in the Galaxy itself.

The problem of determining the distance of a star from the earth is one which taxes the highest resources of the observing astronomer. Of all the millions of the celestial host there are hardly 100 stars whose distances have been measured with accuracy by those surveying operations by which alone this problem can be accurately solved. We are, however, not quite destitute of methods by which we can in some degree estimate the remoteness of other stars, even though the distances may be so great as to elude entirely all the more direct methods of measurements. Suppose that a star were just bright enough to be visible to the unaided eye, and then suppose that particular star were to be withdrawn to a distance ten times as great. It would still remain visible to us by the help of a small telescope. If the star were withdrawn to a distance 100 times as great, it would still generally remain within the ken of a large telescope. When, therefore, our large telescopes reveal millions of stars, which seem just on the verge of visibility, it is plain that those stars, assuming that they are intrinsically as bright as the stars which can just be seen with the eye, must be at least 100 times as remote.

It should also be observed that a star as bright as Sirius would still be visible to the unaided eye, though, of course, only as a very small point, if it were translated to a distance ten times as great as that at which it is now situated; if Sirius were at a distance 100 fold greater than that at which it now lies, it would still be found within the range of a telescope of moderate power. Indeed, if Sirius were at a distance 1,000 times as great as that by which it is at present separated from us, it would still not have passed beyond the ken of our mightiest telescope. We have thus sound reasons for our belief that some of the stars which we can see through our great telescopes are at least 1,000 times as remote as Sirius.

Recent researches made by Dr. Gill and Dr. Elkins, at the Cape of Good Hope, have demonstrated what the distance of Sirius amounts to. It has been shown that the rays from Sirius, traveling as they do with the stupendous speed of light, namely, at the rate of 180,000 miles each second, would nevertheless require not less than nine years to traverse the distance between that star and our system. In other words, when we are looking at Sirius to-night we do not see that star as it is at present, but we see it as it was nine years ago. The light which reaches our eyes to-night must, in fact, have left the star nine years before. We have already shown that there is good reason for the belief that there are stars which are still visible in our great telescopes, notwithstanding that they are 1,000 times further from us than the brilliant Sirius. It follows by a line of reasoning which it seems impossible to question, that the light of such a star must have occupied a period of not less than 9,000 years in its journey to the earth. The consequences of such a calculation are indeed momentous. It is plain that we do not see such stars as they are to-night, but as they were when our earth was 9,000 years younger. The light from such stars which is now entering our eyes at the close of this unparalleled journey has occupied all that long interval in crossing the abyss which intervenes between the solar system and the awful stellar depths. This vast time has been required for the journey, notwithstanding the fact that the light speeds on its way with a velocity which would carry it seven times around the earth in a second. Indeed, the stars might have totally ceased to exist for the past 9,000 years and we should still find them shining in their places. Not until all the light which was on its way to earth at the time of the star's extinction had entered our eyes would the tidings of that extinction have become known to us. We are looking at such stars as they existed long before the earliest period to which any records of human history extend.

We can illustrate the same subject in another way. Suppose that there were astronomers in those remote stars, and that they were equipped with telescopes enormously more powerful than any telescopes which we have ever constructed. Suppose that, notwithstanding the vast distance at which they lie, they had the means of scruntinizing carefully the features of this earth. In what condition would our globe be presented from this point of view? These distant observers would not see any traces of the cities and the nations that now exist. Britain would appear to them as a forest inhabited by a few savages, and North America would be the home of the bison and the red man. They would look down on an Egypt in which the pyramids had not yet been built, and they might survey the sites of Babylon and Nineveh long ere those famous cities had been reared.

Besides those sidereal objects of which we have spoken there are of course others seemingly as numerous as the sands on the seashore. No spectacle which the heavens display is more impressive to the beholder than that of a globular cluster, in which thousands of stars are beheld packed closely together within the limits of his field of view. Each of those stars is itself a sun, the whole forming a dense group of associated suns. Indescribable indeed must be the glory which would shine upon a planet which was situated in such a system. It seems, however, impossible that planets in association with thousands of suns, such as are found in a globular cluster, could possess climatic conditions of sufficient constancy to meet the requirements of organic life.

For the development of life practical stability of climate would seem to be essential. Such conditions could, so far as we know, only be secured in a system like our own, which is controlled by a single sun around which the several planets revolve. In such a case there would be no disturbances to the regular motion of each planet, except those trifling ones arising from the attraction of the other planets equally beholden to the central luminary. But a planet primarily attached to one of the suns belonging to a globular cluster would be so much disturbed in its revolution by the attractions of the other surrounding suns that the movement of the body would in all probability be too irregular to be compatible with any stable climatic conditions. The vicissitudes of climate with which we dwellers on the earth are familiar would seem as nothing in comparison with the vicissitudes of climate in a planet belonging to a system of several suns. It would seem that occasionally the planet must come so near to one or other of the attracting suns that if any life had existed on such a planet it would necessarily be scorched to destruction.

Besides these globular clusters, the heavens contain many other associations of stars arranged in striking groups. We may mention, for instance, the famous cluster in Perseus, an object of indescribable beauty, which fortunately lies within the reach of telescopes of comparatively moderate power. There are also many clusters so distant that the stars are hardly to be discerned separately, in which case the object looks like a nebula, and the resolution of the nebula, as it is called—that is, the perception of the isolated stars of which the nebulous-looking object is formed—becomes a problem which can only be solved by the very highest telescope power.

It has been conjectured that these dim and distant clusters may be associations of stars very like that Milky Way which is relatively quite close to the solar system. It may, indeed, be the case that a sidereal group like the Milky Way would, if transferred to an extremely remote part of the universe, present much the same appearance in our telescopes as one of these nebulous clusters does at present.

Magnificent as are all the sidereal systems displayed to our observation, we ought still to remember that there is a limit to our vision. Even the largest and most brilliant of suns might be so remote as to be entirely beyond the ken of the greatest of telescopes and the most sensitive of photographic plates. Doubtless stars exist in profusion elsewhere than in those parts of space which alone come within range of our instruments. As space is boundless, it follows that the regions through which our telescopes have hitherto conveyed our vision must be as nothing in comparison with the realms whose contents must ever remain utterly unknown. Innumerable as may seem the stars whose existence is already manifest, there is every reason to believe that they do not amount to one-millionth part of the stars which occupy the impenetrable depths of the firmament.—Robert Ball, in New York Sun.

The highest points of the three Swiss railway tunnels, the Mont Cenis, St. Gothard and the Simplon, are 1249·70, 1154·60 and 705·20 meters above sea level respectively.